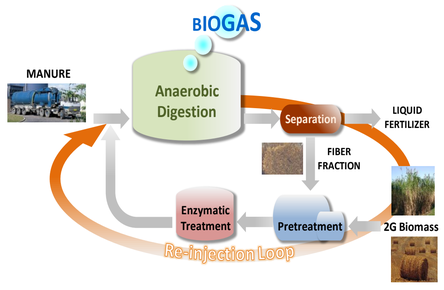
The Re-injection Loop concept

Economically efficient biogas production from manure fibres and straw

Holst Fischer, Christian; Malmgren-Hansen, Bjørn; Uellendahl, Hinrich; Ruiz, Begoña; Kragelund, Caroline

Publication date:
2014

Document Version
Accepted author manuscript, peer reviewed version



The Re-injection Loop concept

Economically efficient biogas production from manure fibres and straw

C. Holst Fischer[1], B. Malmgren-Hansen[1*], H. Uellendahl[2], B. Ruiz[3] and C. Kragelund[1]

[1] Danish Technological Institute, Kongsvang Allé 29, DK-8000 Aarhus C, Denmark, *corresponding author bmh@dti.dk

[2] Section for Sustainable Biotechnology, Aalborg University Copenhagen, A C Meyers Vænge 15, 2450 Copenhagen SV, Denmark.

[3] ainia centro tecnológico, Parque Tecnológico de Valencia c. Benjamin Franklin 5-11, E-46980 Paterna (Valencia), Spain

Introduction

There is a huge unexploited biogas potential from manure and agricultural residues in Europe and worldwide. However, these substrates consist of a large fraction of fibres (range 5-80% of dry matter content) with a low methane potential and represent a marginal economy due to their low biogas yield per ton. Based on previous studies on using pretreatment for enhancing the biogas yield of these feedstocks, a new concept called Re-Injection Loop was developed by combining separation and recirculation of the digested fiber fraction with pretreatment of the recalcitrant lignocellulosic fiber fraction. The EU project BIOMAN is currently investigating different technologies for separation, mechanical pretreatment and enzymatic hydrolysis to establish an economically viable concept for manure-based biogas plants.

The Re-Injection Loop Concept

The Re-injection Loop concept combines solid separation and treatment of the solid fraction in a new innovative approach, see **Figure 1**.

1. Digestion of the easily degradable fraction of manure in the biogas process.
2. Separation of the residual recalcitrant digested fiber fraction.
3. Mechanical and/or enzymatic treatment of the digested fiber fraction.
4. Recirculation of the treated fiber fraction into the reactor.

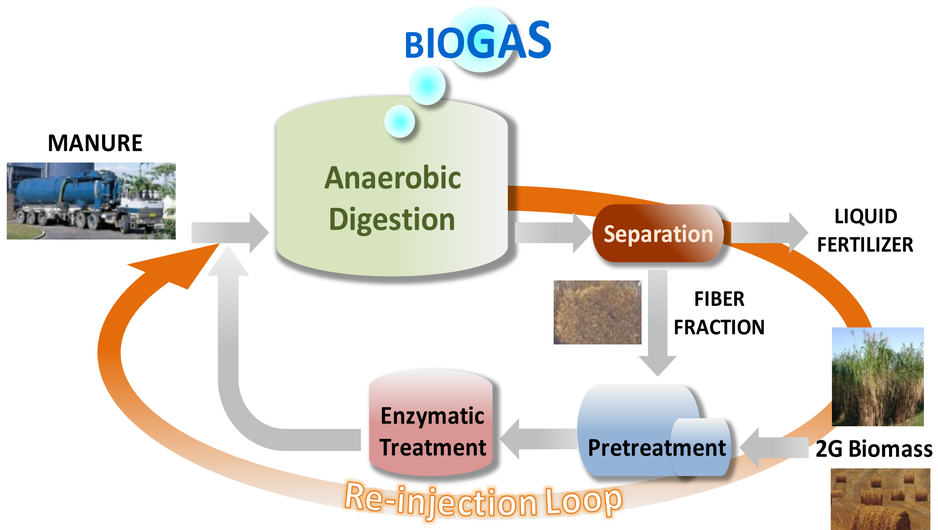


Figure 1. Overview of the Re-Injection Loop concept

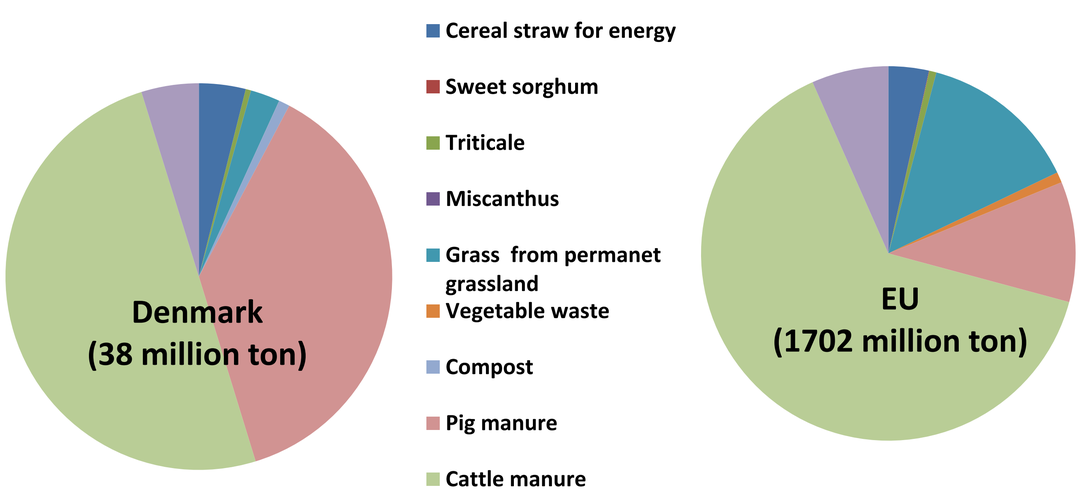


Figure 2. Potential agricultural residues and organic waste in Denmark and in EU Member States applicable for the Re-Injection Loop.

Experimental approach and results

BioMethane Potential (BMP) tests were conducted on digested manure fibres using different separation techniques, physical pretreatment and enzymatic treatment. Different separation technologies were used and potential methane yield increase only by recirculation of the separated digested manure fibers (DMF) is shown in **Table 1**. Physical pretreatment was performed using ultrasound and PureteQ Minimeizer technology, and enzymatic treatment was tested using enzyme blends with cellulase and hemicellulase activity. The BMP increase by mechanical treatment of the DMF using PureteQ Minimeizer technology is depicted in **Figure 3** and in **Figure 4** effect of enzymatic treatment.

Table 1. Calculated increase in methane production for recirculation of the digested fiber fraction using different separation techniques

Separation method	Inlet TS (% w/w)	Solid fraction TS (% w/w)	Liquid fraction TS (% w/w)	% VS of total in solid fraction	Potential CH4 yield increase % (only recirculation)
Centrifugation	5.8	27	2.9	62	20
Screw press	5.1	31.3	3.7	39	11
Bow Screen	5.8	8.2	4.4	58	20

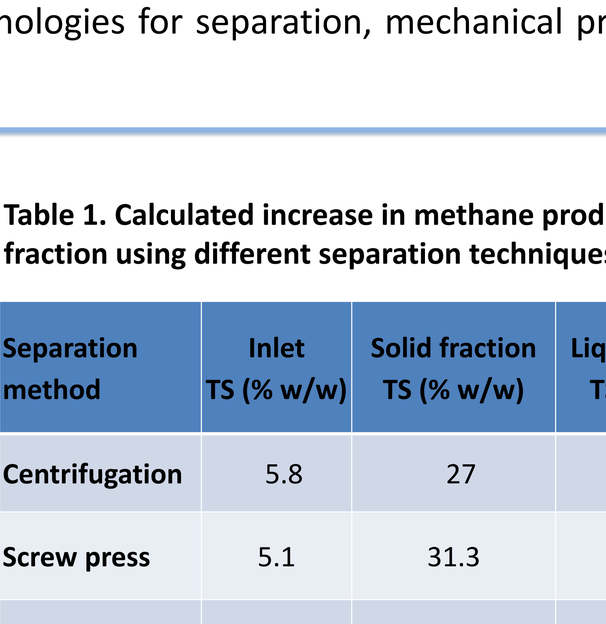


Figure 3. BMP of separated digested manure fibers (DMF), untreated and treated by PureteQ Minimeizer technology

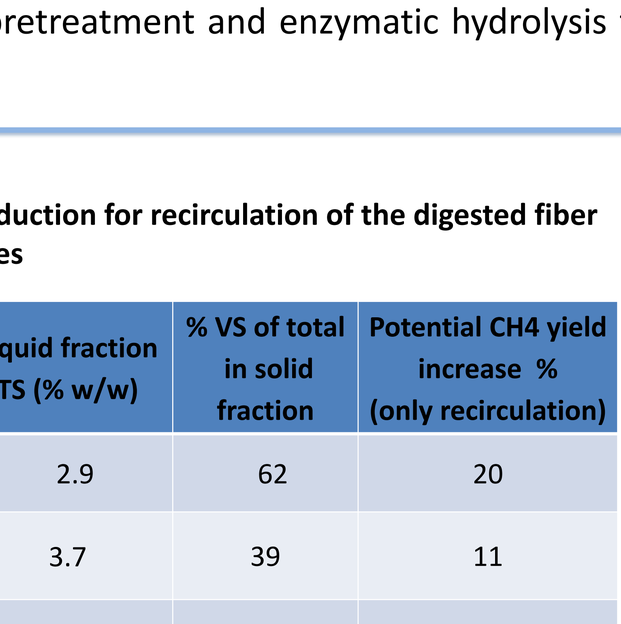


Figure 4. BMP of separated digested manure fibers, untreated and treated with enzymes (dosage 0.1% (g/g-TS), for 0.5 h at 50°C and 42°C

Conclusions and perspectives

- Recirculation of the DMF in the Re-Injection Loop can increase methane production per ton of manure by up to 21%
- Mechanical pretreatment of DMF showed an increase of the methane yield of the DMF by 15%.
- Enzymatic treatment of DMF showed an increase of the methane yield of DMF up to 20%
- The most effective combination of separation, mechanical pretreatment and enzymatic hydrolysis will be tested in 30 L pilot scale reactors and full scale implementation will be at HTN.
- Economical analysis for a manure based biogas plant and the potential for the EU marked will be conducted based on the pilot and full scale results

Acknowledgement

BIOMAN is funded by the European Union's Seventh Framework Programme managed by REA - Research Executive Agency: http://ec.europa.eu/research/rea (FP7/2007-2013) under grant agreement n^0 FP7-SME-2012, 315664, "**BIOMAN**".